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DEVELOPMENT OF A MICRO-MINIATURE RECEIVER

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1.0 INTRODUCTION

This proposal briefly outlines the objectives of a development program which would be undertaken by the [redacted] 25X1

[redacted] The overall objective of the program would be the development of a micro-miniature solid-state receiver. The proposed operating characteristics of the receiver, as indicated in Section 3 of this proposal, are tentative and may be modified or expanded as required by the customer. 25X1

Section 2 of this proposal briefly outlines the objectives and accomplishments of the micro-miniature program currently in progress at the [redacted]. Section 3 includes a description of the three units which make up the complete receiver system. The first unit is a plug-in assembly consisting of a tuned RF stage, crystal controlled local oscillator and mixer. The second unit incorporates the IF stages, a detector, beat frequency oscillator and audio amplifier. The last unit is a plug-in selective call circuit designed to meet specifications similar to those used for the development of the unit which was delivered in the latter part of 1958. 25X1

Throughout the development program, effort will be directed towards the use of the latest circuit techniques and components consistent with reliable operation of the receiver.

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2.0 MICRO-COMPONENT TECHNIQUES

[redacted] 25X1 25X1 have been pursuing a joint program in the field of Solid State Microelectronics. The approach taken has been both practical and versatile. The essential form factor is two-dimensional leading to the generic designation <u>thin circuits</u>.

The thin circuit approach involves the utilization of a thin insulating substrate upon which the circuit is fabricated. Some elements are formed directly on the substrate by vacuum deposition or other means; these include such passive elements as resistors and capacitors as well as conducting runs for interconnections. Additional elements are packaged separately and subsequently incorporated in the circuit; these include active and passive elements such as micro-transistors, micro-diodes, micro-tunnel diodes, some capacitors and inductors. This fabrication philosophy allows pre-selection of critical components of demonstrated ability and reliability.

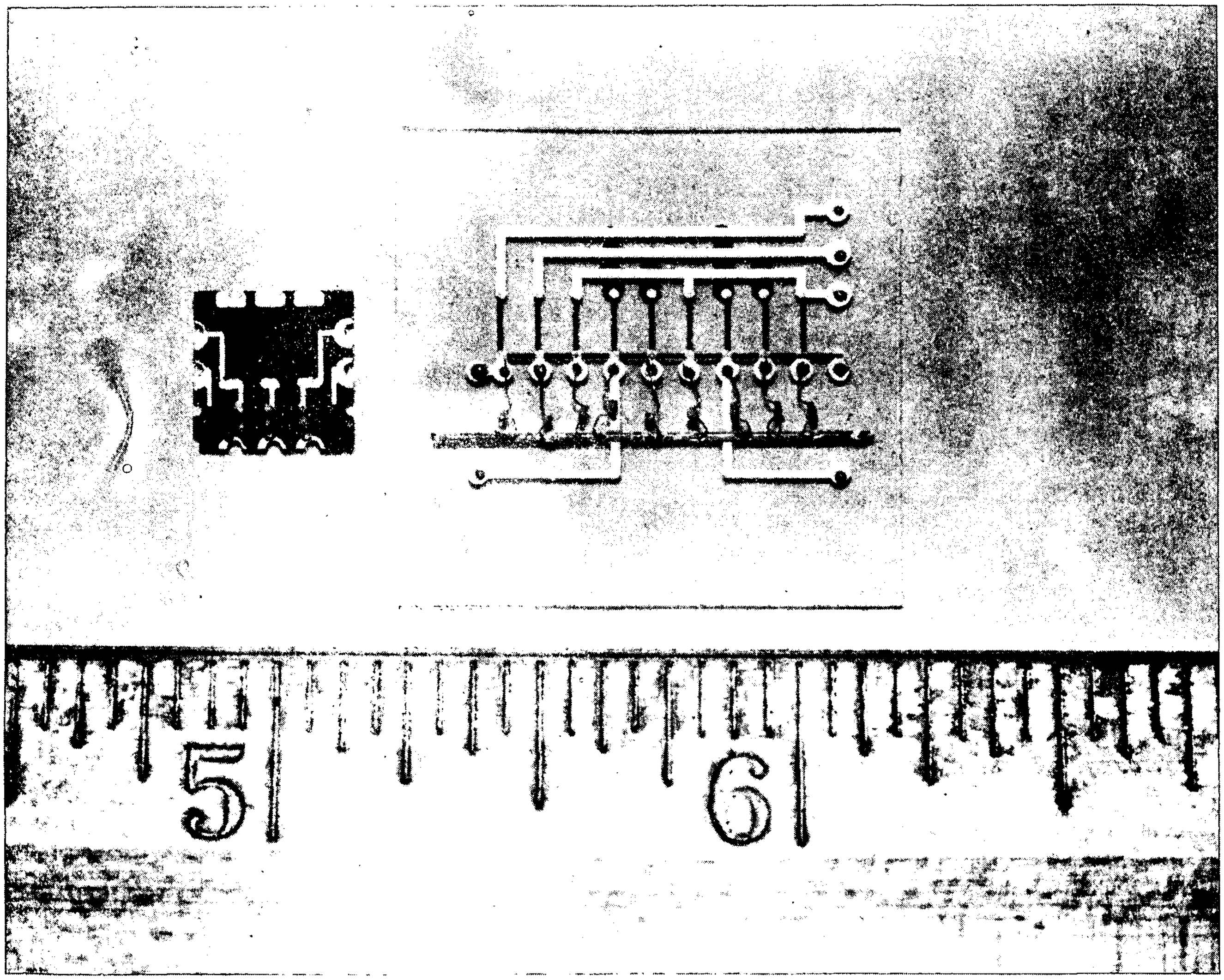
The result of this program has been the development of the equipment and techniques necessary for the fabrication of the micro-components. Transistors, diodes and reference diodes have been packaged in small pillbox enclosures. The dimensions of these enclosures are 50 mils diameter, 15 to 25 mils high. Since tunnel diodes are much less affected by surface conditions than any other semiconductor device, they do not require a hermetic package for most applications. Peak currents for the tunnel diodes can be obtained in the 1 to 10 ma range with a tolerance of 5% or better.

Thin film resistors using a nickel chromium alloy have been deposited by evaporation techniques. This alloy has a relatively high resistivity and enjoys a low temperature coefficient of resistivity. Furthermore, when properly processed, it is stable against aging. The lower practical limit of film resistance that has been reached is approximately 20 ohms per square. The upper practical limit is about 250 ohms per square which means that a 25,000-ohm resistor can be made by using a film strip 10 mils wide and one inch long.

Thin film capacitors have been fabricated using various dielectric materials such as silicon monoxide and anodized tantalum. Capacitors in the range from 20,000 to 80,000 μμf per square inch have been made with dissipation factors less than 2% at 10 mc.

Typical micro-miniature circuits fabricated and evaluated during the present effort are illustrated in Figures 1 and 2. Figure 1 shows arrays of micro tunnel diodes in resistance-coupled shift register circuits. One of the circuits shown is a three-phase, three-stage shift register with nine tunnel diodes and 18 evaporated resistors. The other circuit is a shift register stage on a Signal Corps Micro-Module wafer, containing three tunnel diodes and seven evaporated resistors.

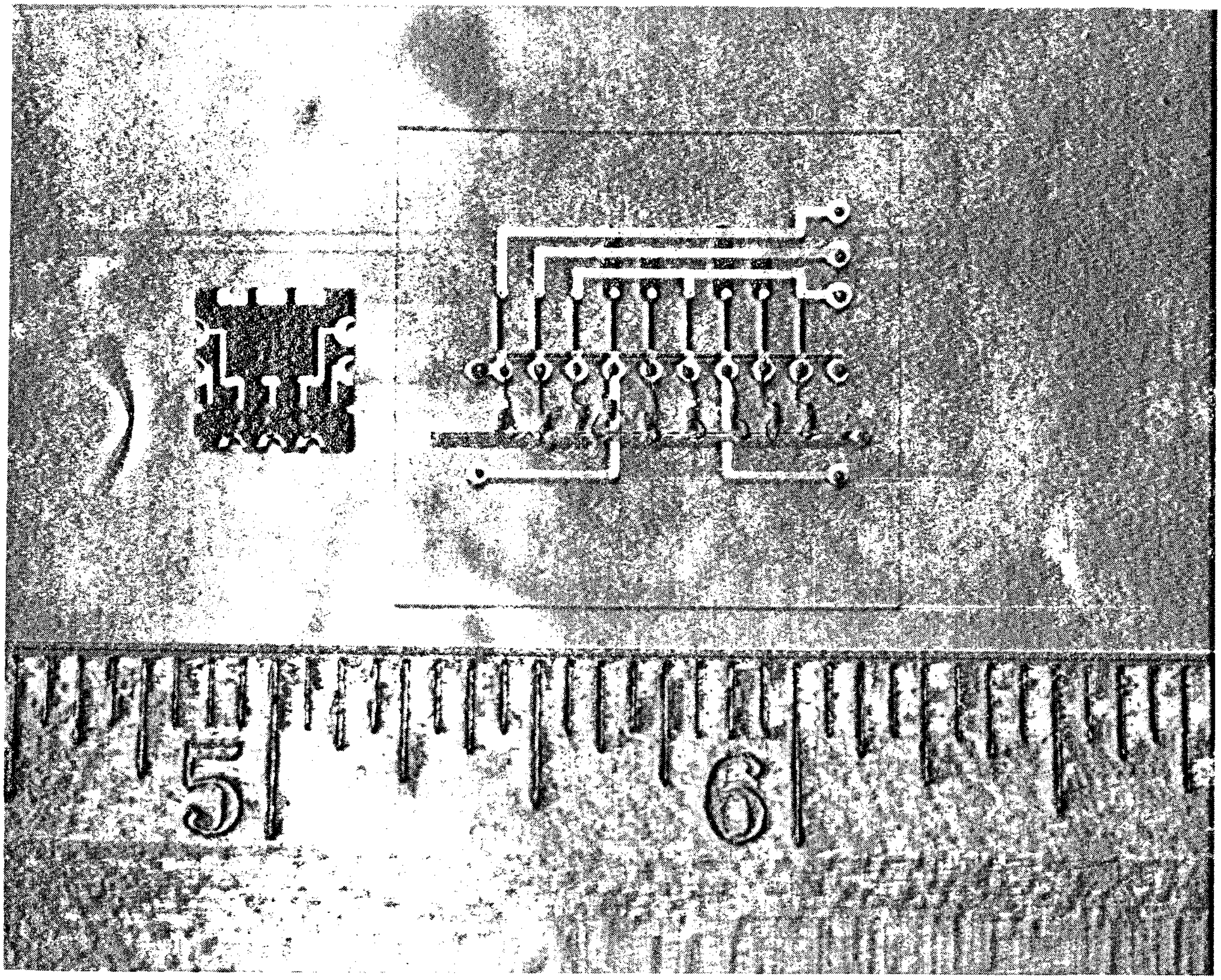
Figure 2 is a double NOR circuit containing four evaporated resistors, two titanate wafer capacitors, two transistors, two voltage reference diodes, and four diodes. The two transistors are located at center-top; the four diodes; upper right and left side; and the two reference diodes, right and left center.



(a) One-stage Tunnel Diode Shift Register on Signal Corp wafer (3 diodes, 7 resistors)

(b) Three-stage Tunnel Diode Shift Register (3 Diodes and 6 resistors per stage)

Figure 1. Micro Tunnel Diode Shift Registers



(a) One-stage Tunnel Diode Shift Register on Signal Corp wafer (3 diodes, 7 resistors)

(b) Three-stage Tunnel Diode Shift Register (3 Diodes and 6 resistors per stage)

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3.0 RECEIVER DESCRIPTION

Figure 3 indicates the block diagram of the proposed micro-miniature receiver. The tentative characteristics of the three units are described in the following sections.

3.1 RF Circuitry (Unit No. 1)

Unit No. 1 will consist of an RF stage, a crystal controlled local oscillator, and a mixer. The RF stage will provide amplification as well as frequency selectivity necessary with particular emphasis on image rejection. The crystal controlled local oscillator will provide the required signal to the mixer so that the output frequency of the unit will be at 455 kc.

These fixed tuned units will be of the plug-in type. In this way various plug-in units may be interchanged and thus provide for reception at discrete frequencies over the range from 3 to 30 mc.

In the development of unit No. 1 considerable emphasis will be placed on the possibility of utilizing tunnel diodes as the active elements. The operating characteristics of these devices indicate the possibility of improved performance combined with circuit simplicity when compared with conventional transistor circuitry. This is particularly important when micro-electronic circuitry is considered.

It is anticipated that the maximum overall volume of this plug-in circuit will be in the order of 0.5 cubic inches.

3.2 Main Receiver Unit (Unit No. 2)

Unit No. 2 will consist of the IF stages (probably three), the detector, the beat frequency oscillator, and an audio amplifier.

The three-stage IF amplifier will make use of the barium titanate transformers which have been developed during previous programs. These devices provide the required impedance matching and frequency selectivity in a minimum amount of space. The IF amplifier will be fixed tuned at a frequency of 455 kc. The detector will utilize a micro-diode in conjunction with the beat frequency oscillator to provide an audio tone on CW transmissions.

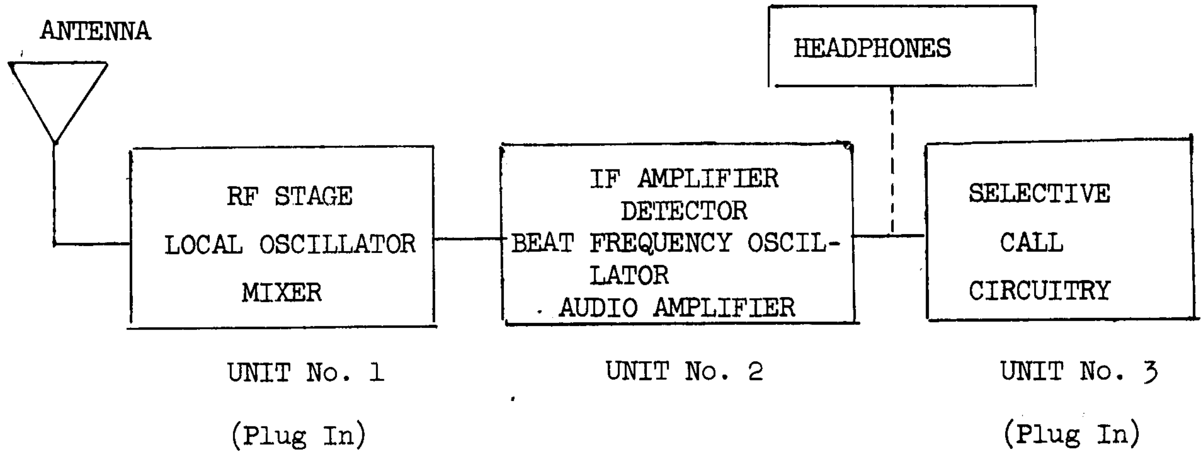

Figure 3. Block Diagram of the Proposed Micro-Miniature Receiver

The latest circuit techniques and devices will be examined in the course of the design in order to optimize reliability, receiver performance, and minimize physical size. In particular, the possible use of a tunnel diode as the BFO will be carefully studied.

It is anticipated that unit No. 2 will occupy a maximum overall volume of 0.5 cubic inches. Thus units 1 and 2, which comprise a complete fixed tuned receiver will occupy a total volume of less than 1.0 cubic inch. The exact form factor that this volume will occupy is open to final determination by the customer.

3.3 Selective Call Circuitry (Unit No. 3)

The selective call unit will be of the plug-in type and may be substituted for the earphones in the jack of unit No. 2. The operating characteristics of this unit will be similar to those of the selective call unit already delivered to the customer. It will provide for the alerting of a single station out of approximately one thousand receivers.

This selection will be made by the transmission of a particular code which corresponds with a code previously set into the receiver.

Briefly, when a code group is received, it is compared, bit by bit with a code previously set in the selective call unit. If both codes are the same, a signal is passed to the alarm circuit. Any difference will cause the message to be rejected and the alarm circuit will not be allowed to function.

A plug-in selective call unit of this type will occupy a maximum volume of approximately one cubic inch.